

(Ormsby) and Pollara, F. and Chen, T. "Rate-Distortion Efficiency of Subband Coding with Integer Coefficient Filters," IEEE International Symposium on Information Theory, pg. 419, June 1994 (Pollara) or Applicant's Admitted Prior Art.

Claim 1 recites the following:

applying an overlapped reversible wavelet transform to the input data to produce a series of coefficients, wherein the overlapped reversible wavelet transform is implemented in integer arithmetic such that, with integer coefficients, integer input data is losslessly recoverable; and compressing the series of coefficients into data representing a compressed version of the input data, including context modeling bits of each of the series of coefficients based on known coefficients in other frequency bands and neighboring coefficients in the same frequency band.

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Thus, Applicants claim an overlapped reversible wavelet transform applied to input data.

The reversible transform is implemented in integer arithmetic, such that, with integer coefficients, the input data is losslessly recoverable. Claims 13, 17, 22 and 23 similarly recite an overlapped reversible wavelet transform is implemented in integer arithmetic such that, with integer coefficients, integer input data is losslessly recoverable.

As a preliminary matter, **Applicants must point out that the J. W. Woods paper cited by Shapiro is not the J. W. Woods paper cited in the Office Actions.**

Shapiro cites reference [32] as support for filter design. The reference section of *Shapiro* recites the following:

[32] J. W. Woods, Ed., *Subband Image Coding*, Boston, MA: Kluwer, 1991.

See page 3462, second column. The reference cited in the Office Action is J. W. Woods and S. D. O'Neil, "Subband coding of images," IEEE Trans. Acoustics, Speech, and Sig. Proc., vol. 34, pp. 1278-1288, Oct. 1986, which is clearly a different reference.

Therefore, the reasoning that *Woods* should be combined with *Shapiro* because *Shapiro* includes a reference to *Woods* is faulty. Because nothing in either *Shapiro* or *Woods* (as

cited in the Office Action, not by *Shapiro*) suggests the combination proposed by the Office Action, Applicants submit that combination of *Shapiro* and *Woods* is improper.

Shapiro does not explicitly disclose an overlapped transform and does not disclose or suggest integer coefficients generated using integer arithmetic. Even if *Woods* is combined with *Shapiro*, *Woods* does not cure these deficiencies. For example, *Woods* discloses various coefficients for the "Lady" example on page 1286. The coefficients are not integer coefficients (See Table I on page 1286), which indicate that *Woods* does not disclose integer arithmetic. The coefficients are then rounded to be integer values. See Table II on page 1286.

The Office Action states that *Ormsby* should be combined with *Shapiro* because *Ormsby* improves upon a reference (*Whitten*) cited by *Shapiro*. However, nothing in *Ormsby* provides a teaching or a motivation to cure the deficiencies of *Shapiro* and *Woods* as to integer arithmetic.

The Office Action further combines Applicant's Admitted Prior Art at page 22 of the Specification or *Pollara* with *Shapiro*, *Woods* and *Ormsby* as rendering claims 1, 13, 17, 22 and 23 obvious. Applicant's Admitted Prior Art recites a reversible S-transform. See page 22, lines 8-10. However, the reversible S-transform is not an overlapping transform, which is recited by claims 1, 13, 17, 22 and 23 and allegedly taught by a combination of *Shapiro* and *Woods*. Furthermore, the coefficients are forced to be integer coefficients by rounding (floor and ceiling functions). Therefore, combining Applicant's Admitted Prior Art with the teachings of *Shapiro*, *Woods* and *Ormsby* does not result in the method of claims 1, 13, 17, 22 and 23.

Pollara discloses an image compression algorithm that uses quadrature mirror filters with integer coefficients. Specifically, *Pollara* discloses a JPEG-like technique, which is not a losslessly recoverable technique. Therefore, as with *Shapiro* and *Woods* discussed above, *Pollara* does not disclose a wavelet transform is implemented in integer arithmetic such that with integer coefficients, integer input data is losslessly recoverable. Therefore, combination of *Shapiro*, *Woods*, *Ormsby* and *Pollara* does not render the method of claims 1, 13, 17, 22 and 23 obvious.

Claims 4-7, 25 and 33 depend from claim 1. Claims 15, 16, 28 and 35 depend from claim 13. Claims 18-21, 29 and 36 depend from claim 17. Claims 30 and 37 depend from claim 22. Claims 24, 31 and 38 depend from claim 23. Because dependent claims include the limitations of the claims from which they depend, Applicants submit that claims 4-7, 15, 16, 18-21, 24, 25, 28-31, 33 and 35-38 are not rendered obvious by any combination of *Shapiro*, *Woods*, *Ormsby*, *Pollara* and Applicant's Admitted Prior Art for at least the reasons set forth above.

Claim 8 recites the following:

generating a reconstructed version of original data from the plurality of transformed signals with an overlapped inverse reversible wavelet transform, wherein the overlapped inverse reversible wavelet transform is implemented in integer arithmetic such that, with integer coefficients, integer reconstructed original data is losslessly recoverable.

Thus, Applicants claim reconstruction using an inverse reversible wavelet transform implemented using integer arithmetic. Claim 32 similarly recites reconstruction using an inverse reversible wavelet transform implemented using integer arithmetic.

As discussed above, no combination of *Shapiro*, *Woods*, *Ormsby*, *Pollara* and Applicant's Admitted Prior Art teaches or suggests using a reversible wavelet transform implemented using integer arithmetic. Therefore, no combination of *Shapiro*, *Woods*,

Ormsby, Pollara and Applicant's Admitted Prior Art teaches or suggests the inverse operation as claimed in claims 8 and 32.

Claims 26 and 34 depend from claim 8. Because dependent claims include the limitations of the claims from which they depend, Applicants submit that claims 26 and 34 are not rendered obvious by combination of *Shapiro, Woods, Ormsby, Pollara* and Applicant's Admitted Prior Art for at least the reasons set forth above.

Claim 12 recites the following:

generating a first plurality of transformed signals in response to the input data with a reversible overlapped wavelet transform using a pair of non-minimal length reversible filters, implemented in integer arithmetic such that, with integer signals, integer input data is losslessly recoverable; ... and

generating the input data from the second plurality of transformed signals into a reconstructed version of the input data with an inverse reversible overlapped wavelet transform using a second pair of non-minimal length reversible filters.

Thus, Applicants claim both encoding using a reversible overlapped wavelet transform and decoding using an inverse reversible overlapped wavelet transform. Both the encoding and decoding are implemented in integer arithmetic such that with integer signals, integer input data is losslessly recoverable.

As discussed above, no combination of *Shapiro, Woods, Ormsby, Pollara* and Applicant's Admitted Prior Art teaches or suggests using a reversible wavelet transform implemented using integer arithmetic or the inverse operation. Therefore, no combination of *Shapiro, Woods, Ormsby, Pollara* and Applicant's Admitted Prior Art teaches or suggests the invention as claimed in claim 12.

Claim 27 depends from claim 12. Because dependent claims include the limitations of the claims from which they depend, Applicants submit that claim 27 is not

rendered obvious by combination of *Shapiro*, *Woods*, *Ormsby*, *Pollara* and Applicant's Admitted Prior Art for at least the reasons set forth above.

Claims 44-50 were rejected as being unpatentable over *Shapiro* in view of *Woods*, *Ormsby* and *Pollara* or Applicant's Admitted Prior Art in further view of U.S. Patent No. 5,495,292 issued to Zhang, et al. (*Zhang*). For at least the reasons set forth below, Applicants submit that claims 44-50 are not rendered obvious by any combination of *Shapiro*, *Woods*, *Ormsby*, *Pollara*, Applicant's Admitted Prior Art and *Zhang*.

Claims 44-50 each depend from one of the independent claims discussed above and generally recite that the determinant of the overlapped reversible wavelet transform is equal to 1. *Shapiro* recites:

...using properly scaled coefficients, the transformation matrix for a discrete wavelet transform obtained using these filters is so close to unitary that it can be treated as unitary for the purpose of lossy compression.

See page 3448, first full paragraph, left column (emphasis added). Thus, even if *Shapiro* suggests use of a transform with a determinant of 1, that is for lossy compression, not for lossless compression as recited in the independent claims. Therefore, in addition to the shortcomings discussed above, *Shapiro* does not teach or suggest the limitations of claims 44-50.

Claims 39, 40 and 42 were rejected under 35 U.S.C. § 103(a) as being unpatentable over *Shapiro* in view of *Woods* and *Pollara* or Applicant's Admitted Prior Art. For at least the reasons set forth below, Applicants submit that claims 39, 40 and 42 are not rendered obvious by any combination of *Shapiro*, *Woods*, *Pollara* and Applicant's Admitted Prior Art.

The reversible Two/Ten wavelet transform recited in claims 39, 40 and 42 are not disclosed or suggested in any of *Shapiro*, *Woods*, *Pollara* and Applicant's Admitted Prior Art. Moreover, the reversible Two/Ten wavelet transform is not considered a filter that is conventional. Therefore, Applicants submit that no combination of *Shapiro*, *Woods*, *Pollara* and Applicant's Admitted Prior Art teaches or suggests the invention as claimed in claims 39, 40 and 42.

Claims 41 and 43 were rejected under 35 U.S.C. § 103(a) as being unpatentable over *Shapiro* in view of *Woods* and *Pollara* or Applicant's Admitted Prior Art and further in view of *Ormsby*. For at least the reasons set forth below, Applicants submit that claims 41 and 43 are not rendered obvious by any combination of *Shapiro*, *Woods*, *Pollara*, Applicant's Admitted Prior Art and *Ormsby*.

Claims 41 and 43 were rejected for the same reasons as claim 1. Applicants submit that claims 41 and 43 are not rendered obvious by *Shapiro*, *Woods*, *Polara*, Applicants' Admitted Prior Art and *Ormsby*, for at least the reasons set forth above with respect to claim 1.

Claims 51 and 52 were rejected under 35 U.S.C. § 103(a) as being unpatentable over *Shapiro* in view of *Woods* and *Pollara* or Applicant's Admitted Prior Art in further view of *Zhang*. For at least the reasons set forth below, Applicants submit that claims 51 and 52 are not rendered obvious by any combination of *Shapiro*, *Woods*, *Pollara*, Applicant's Admitted Prior Art and *Zhang*.

Claims 51 and 52 depend from claims 39 and 42, respectively, which are discussed above. Both claims 51 and 52 recite that the determinant of the reversible transform is equal to 1. As discussed above neither *Shapiro* nor *Zhang* teach or suggest

that the determinant of a transform should be 1 for lossless encoding. Therefore, no combination of *Shapiro*, *Woods*, *Pollara*, Applicant's Admitted Prior Art and *Zhang* teaches or suggests the invention as claimed in claims 51 and 52.

Claims 25-31 were rejected under 35 U.S.C. § 103(a) as being unpatentable over *Shapiro* in view of *Woods*, *Ormsby* and *Pollara* or Applicant's Admitted Prior Art and further in view of U.S. Patent No. 5,481,308 issued to Hartung, et al. (*Hartung*) or Japanese Patent No. JP406038193A issued to Shinichi (*Shinichi*). For at least the reasons set forth below, Applicants submit that claims 25-31 are not rendered obvious by any combination of *Shapiro*, *Woods*, *Pollara*, Applicant's Admitted Prior Art and *Hartung* or *Shinichi*.

Applicants submit that neither *Hartung* nor *Shinichi* teaches or suggests a reversible Two/Ten transform. Therefore, Applicants submit that no combination of *Shapiro*, *Woods*, *Pollara*, Applicant's Admitted Prior Art and *Hartung* or *Shinichi* teaches or suggests the invention as claimed in claims 25-31.

For at least the foregoing reasons, Applicants submit that the rejections have been overcome. Therefore, claims 1, 4-8, 12, 13 and 15-52 are in condition for allowance and such action is earnestly solicited. The Examiner is respectfully requested to contact the undersigned by telephone if such contact would further the examination of the present application.

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Respectfully submitted,
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Date:

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